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that it would be in readiness to pass into *B* at the same time as the heat which originally came from *B* is returned to *B*, though my arrangement of moving screens readily accomplished this, as was admitted by Prof. J. Willard Gibbs in his criticism of my paper.¹

H. T. EDDY, Ph.D.

Area of a plane triangle.

≡ In the *Mathematical magazine* (Erie, Penn.) for April, Mr. James Main publishes, as a matter of curiosity, a collection of ninety-four expressions for the area of a plane triangle. In *Mathesis* (Gand, Belgium) for June this list is republished; and in the August number of the same journal the subject is taken up again by M. Ed. Lucas, who extends the collection, and classifies into five groups. In the first group are eleven 'unique' expressions for the area, i.e., expressions that do not admit of other similar expressions by permuting the letters; in the second group are nine expressions, each admitting of two other similar expressions by permuting the letters; in the third group are eleven expressions, each admitting of three other similar expressions; in the fourth group are seven expressions, each admitting of five similar expressions; and, last, the fifth group consists of a single formula, admitting of eleven similar expressions. Thus we have a hundred and thirty-six expressions for the area of a plane triangle in terms of the sides, angles, perpendiculars, semiperimeter, and radii of the circumscribed, inscribed, and escribed circles. M. Neuberg adds also three other unclassified formulae, with the statement that many other such may be found. The total number of expressions for the area of a plane triangle, in this collection, is therefore a hundred and thirty-nine, making it, perchance, the most complete collection that has been published.

M. B.

The Dora coal-field, Virginia.

In the November number of *The Virginias* is contained a review of the report on the mineral resources of the United States, recently published by the U.S. geological survey, which contains the following:—"In Mr. Charles A. Ashburner's report on anthracite coal, p. 32, is this statement concerning the Dora coal-field: 'Of one of the reported anthracite localities in Virginia, that in Augusta county, recent tests with the diamond-drill would seem to prove the presence of anthracite,' etc. In explanation of the above, I would like to state, that, by referring to the report reviewed, on p. 24 will be found a footnote as follows: 'Mr. Ashburner's contribution and statistics end here.' I only stand responsible for a portion of the statistics relating to the anthracite region in Pennsylvania (pp. 7 to 24 inclusive). I desire to make this explanation public from the fact that I do not wish to be held accountable for questionable data relating to a coal-field of a very uncertain character, and which I have never examined.

CHARLES A. ASHBURNER,

Geologist in charge Penn. anthracite survey.

Philadelphia, Penn.

Synchronism of geological formations.

In *SCIENCE* of Dec. 7 your correspondent, Mr. Nugent, takes issue with me as to my conclusions bearing upon the relative ages of geological formations, and contends that the geological and paleontological researches of the last twenty-one years (i.e., during the period that has elapsed since the publication of Professor Huxley's address referred to in

¹ *SCIENCE*, i. 160.

my communication before the Philadelphia academy of natural sciences) have only tended 'to maintain the logical basis' on which the distinguished English naturalist rested. As the subject is a very important one, and one that has not, it appears to me, received its full measure of attention or discussion, I trust that you will permit me a little space for fuller explanation, even at the risk of repeating what has already been said in your valuable columns.

Professor Huxley, in his anniversary address delivered before the London geological society in 1862 (*Quart. Journ.*, xviii. p. xlv), maintains substantially,—

I. That formations exhibiting the same faunal facies may belong to two or more very distinct periods of the geological scale as now recognized; and, conversely, formations whose faunal elements are quite distinct may be absolutely contemporaneous: e.g., "For any thing that geology or paleontology is able to show to the contrary, a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America, and with a carboniferous fauna and flora in Africa" (*loc. cit.*).

II. That, granting this disparity of age between closely related faunas, all evidence as to the uniformity of physical conditions over the surface of the earth during the same geological period (i.e., the periods of the geological scale), as would appear to be indicated by the similarity of the fossil remains belonging to that period, falls to the ground. "Geographical provinces and zones may have been as distinctly marked in the paleozoic epoch as at present; and those seemingly sudden appearances of new genera and species which we ascribe to new creations may be simple results of migration."

Now, without wishing to enter into the minutiae of the question, I believe a little reflection will clearly show, that if, as it is contended, several distinct faunas (i.e., faunas characteristic of distinct geological epochs, and separated in age from each other by possibly millions of years) may have existed contemporaneously, "evidences of inversion," to quote my own words, "in the order of deposit, ought to be common; or, at any rate, they ought to be indicated somewhere, since it can scarcely be conceived that animals everywhere would have observed the same order of direction in their migrations." Given the possible equivalency in age, as hypothetically claimed, of the Silurian fauna of North America with the Devonian of the British Isles and the carboniferous of Africa, or any similar arrangement, why has it never happened, it may be asked, that when migration, necessitated by alterations in the physical conditions of the environs, commenced, a fauna with an earlier life-facies has been imposed upon a later one, as the Devonian of Great Britain upon the carboniferous of Africa, or the American Silurian upon the Devonian of Britain? Or, for that matter, the American Silurian may have just as well been made to succeed the African carboniferous. Reference to the annexed diagram, where *D* represents a Devonian area, say, in Europe, *S* a Silurian one in America, and *C* a carboniferous one in Africa,—all contemporaneous,—will render this point more intelligible.

Now, on the proposition here stated, reasoning from our present knowledge of the antiquity of faunas, and accepting the doctrine of migration, as maintained by Professor Huxley and others, to account for the possible contemporaneity of distinct faunas, it may be assumed that *S* (or America) will receive its Devonian fauna from *D*; *D* (Europe), its carboniferous from *C*; and *C* (Africa), a later fauna from some locality not here indicated. In other words, a migra-